



Independent Communications Authority of South Africa

350 Witch-Hazel Avenue, Eco Point Office Park
Eco Park, Centurion.
Private Bag X10, Highveld Park 0169
Telephone number: (012) 568 3000/1

**2019/2020 Quarter 1:
Voice Quality of Service
Report –
Gauteng Province**

Contents

EXECUTIVE SUMMARY	3
1 INTRODUCTION.....	4
2 METHODOLOGY.....	5
2.1 <i>Equipment test setup and configuration</i>	6
2.1.1 <i>System/Equipment used</i>	6
2.2 <i>Route selection.....</i>	6
2.3 <i>Equipment test setup and configuration</i>	7
2.4 <i>Statistical significance.....</i>	8
2.5 <i>Measurement parameters and targets.....</i>	9
2.5.1 <i>Targets.....</i>	9
2.5.1.1 <i>Call Setup Success Ratio [%].....</i>	9
2.5.1.2 <i>Drop Call Ratio [%].....</i>	9
2.5.1.3 <i>Call Setup Time [s].....</i>	10
3 RESULTS AND ANALYSIS	10
3.1 <i>Accessibility and Retainability Measurements.....</i>	10
3.1.1 <i>Call Setup Success Ratio (CSSR).....</i>	11
3.1.2 <i>Drop Call Ratio (DCR).....</i>	12
3.1.3 <i>Call Setup Time (CST).....</i>	13
3.2 <i>Analysis of the serving technology.....</i>	14
4 CONCLUSION	15
5 APPENDICES	16
5.1 <i>Appendix A: Drive Test Results KPI's.....</i>	16
5.2 <i>Appendix B: Coverage Maps.....</i>	18
Serving Technology Details.....	18
5.3 <i>Appendix C: Mobile operators' feedback on the report.....</i>	19
5.3.1 <i>Vodacom.....</i>	19
5.3.2 <i>MTN</i>	20
5.3.3 <i>Cell C.....</i>	20
5.3.4 <i>Telkom.....</i>	20

List of Acronyms

CD	Call Duration
CS	Circuit Switch
CSFB	Circuit Switched FallBack
CSSR	Call Setup Success Ratio
DCR	Drop Call Ratio
GSM	Global System for Mobile Communications
GERAN	GSM EDGE Radio Access Network
IVR	Interactive Voice Response
LTE	Long Term Evolution
WCDMA	Wideband Code Division Multiple Access
MOC	Mobile Originating Call
KPI	Key Performance Indicator
UMTS	Universal Mobile Telecommunications System
UTRAN	UMTS Terrestrial Radio Access Network

EXECUTIVE SUMMARY

The Authority conducted Quality of Service (QoS) measurements on the networks of mobile operators; Cell C, MTN, Telkom and Vodacom. The measurements were performed to monitor performance of voice services offered by the mobile operators in the Gauteng Province. The measurements were carried out in the period 27 May 2019 to 13 June 2019, covering a total distance of over 1800km.

The purpose of performing QoS measurements was to monitor and analyse the quality of mobile voice service as experienced by the end user. The results were later benchmarked against the QoS standard set by the Authority. The measurements were conducted in areas and in circumstances where mobile voice service is likely to be accessed. The sampled areas include Pretoria West, Pretoria North, Bronkhorstspuit, Boksburg and Evaton.

A vehicle equipped with Keysight Nemo Autonomous measurement tool including eight mobile phones were used to collect data in mobility conditions. The three Key Performance Indicators (KPIs) used to evaluate QoS are Retainability, Accessibility and Call Setup Time.

According to the End-User and Subscriber Service Charter Regulations of 2016, DCR should be less than 3% and CSSR should be greater than 98%. Call Setup Time must be less than 20 seconds.

Cell C, MTN and Vodacom met the overall CSSR target of more than 98%, whereas Telkom failed to meet the target. All operators met the overall DCR target of less than 3% and thus meeting the Authority's Retainability target. All operators met the target for Call Setup Time of less than 20 seconds.

1 INTRODUCTION

ICASA’s mission is to ensure that all South Africans have access to a wide range of high-quality communication services at affordable prices¹. The Authority ensures quality of service through its Quality of Service (QoS) monitoring activities. The Authority conducted QoS monitoring of the voice telephony service being offered by Cell C, MTN, Vodacom and Telkom within Gauteng Province of South Africa.

Gauteng is the smallest of South Africa’s provinces, covering an area of 18 178 km² and has a population of 13 399 725 people. It is bordered by the Free State, North West, Limpopo and Mpumalanga provinces. Johannesburg is the capital and the Province also contains the city of Pretoria, as well as the East Rand, West Rand and Vaal areas². Figure 1 shows the drive test routes covered during this period.

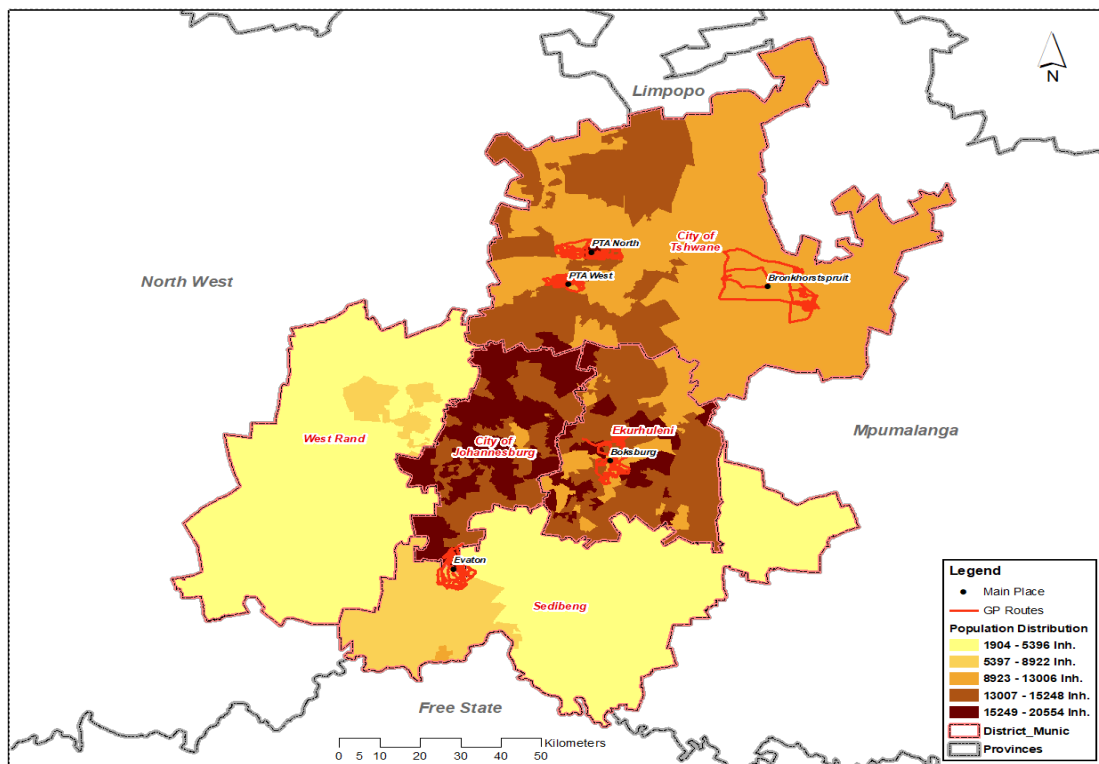


Figure 1: Gauteng Province Route Map

The QoS monitoring was conducted in the areas within City of Johannesburg, City of Tshwane, City of Ekurhuleni and Sedibeng District Municipality. The selected

¹ ICASA Strategic Plan 2016/17-2021

² <http://www.localgovernment.co.za/provinces/view/3/gauteng>

areas include Pretoria West, Pretoria North, Bronkhorstspuit, Boksburg and Evaton.

QoS is defined as the collective effect of service performance that determines the degree of satisfaction a user derives from a service. It provides an indication of what a customer experiences when using a mobile network. ICASA has selected Call Accessibility, Call Setup Time and Call Retainability parameters to evaluate QoS. These parameters are described briefly below:

- a) Call Accessibility is defined as a percentage and is a measure of the number of times a user is able to successfully establish a call as a percentage of the total calls attempted. It is measured using Call Setup Success Ratio (CSSR).
- b) Call Setup Time is the time interval from the instant a user initiates a network connection request until a complete message indicating call disposition is received by the calling terminal. It is measured from the time a user presses the dial button until the user gets connected to the dialed party.
- c) Retainability is defined as the ability for a call to stay connected through to a normal call tear-down process, without abnormally disconnecting from the cell site that carries the call. It is measured using Drop Call Ratio (DCR).

2 METHODOLOGY

A drive-test sampling methodology which provides a snapshot view of the mobile operator's quality of service was adopted. It provides a realistic picture of network performance from a user's point of view. The method adopted provides a snapshot of an operator's network performance on the selected routes and a particular time of the day.

Voice test set-up consisted of two categories which are short call (accessibility) and long call (retainability). The Call Window was set up as follows:

- (i) Call duration + 30 seconds (for the setup and release phases) + 30 seconds (for the minimum pause interval).
- (ii) The default call duration is 120 seconds for Long Call and thus results in 180 seconds call window. The call duration for Short Call is 10 seconds resulting in 70 seconds call window.

The devices were set to measure the best available technology and barred from making VoLTE calls, thus in the areas where operators had LTE they performed Circuit Switched Fall Back (CSFB) calls. CSFB allows terminal/mobile phones connected on LTE to use GERAN or UTRAN to connect to the CS domain mainly for voice calls.

2.1 Equipment test setup and configuration

2.1.1 System/Equipment used

The drive test was carried out using a test kit comprised of four (4) Keysight Nemo Autonomous probes. Each probe has three Samsung Galaxy S8 (SM-G950F) mobile devices. The mobile devices were configured to automatically select a mobile network and radio access technology.

2.2 Route selection

Measurement routes were selected so that they would reflect end user distribution at different geographical locations in areas where people live and use mobile phones (e.g. urban, suburban, major towns, rural towns, township, farm areas, highways, tourism areas and major roads).

The selected five areas in which the QoS measurements were conducted are within the district municipalities as indicated in Table 1:

Table 1: Selected routes and dates

District	Route Name	Test Date
City of Tshwane	Pretoria West	27/05/2019 03/06/2019
	Pretoria North	28/05/2019 04/06/2019
	Bronkhorstspuit	29/05/2019 05/06/2019
City of Ekurhuleni	Boksburg	30/05/2019 06/06/2019
Sedibeng	Evaton	31/05/2019 10/06/2019

2.3 Equipment test setup and configuration

Table 2 shows the test plan and configurations of the drive-test equipment.

Table 2: Test plan and configurations

Configuration	Explanation
Antennas	Device Antennas were used as per SANS 1725-2 ³
Technologies	GSM, UMTS and LTE CSFB
Call Samples	<p>A minimum of 120 test samples per network operator were collected except in the areas where services were limited on most part of the drive test route. Drive tests were planned to ensure, as far as practicable, that the results adequately reflect the QoS perceived by customers for the period under review.</p> <p>The drive tests were designed to be representative of the population relative to the traffic of the network. Measurements were scheduled to reflect accurately the traffic variations over the hours of a day, and user's behavior⁴.</p>
Call Type and Window Call	<p>Long calls and short calls were used.</p> <p>Voice telephony was tested in the Mobile Originating Call (MOC) direction. The following call durations (CD) were used:</p> <ul style="list-style-type: none"> • CD1: 10 seconds for call setup testing; • CD2: 120 seconds for typical tests, default call duration; <p>Call Window: Call Duration + 30 seconds (for the setup and release phases) + 30 seconds (for the minimum pause interval). Thus, the default call duration for Long Call resulted in 180 seconds and 70 seconds for a Short Call⁵.</p>

³ SABS Standard, SANS 1725-2:2019 End user related Quality of Service parameter definitions and measurements, Part 2: Mobile data services

⁴ SABS Standard, SANS 1725-1:2016 End user related Quality of Service parameter definitions and measurements, Part 2: GSM voice services

⁵ Ibid

Equipment	The equipment used for testing was the Keysight Nemo Autonomous probe with 3 x Samsung Galaxy S8 (SM-G950F) phones in each probe.
KPI ⁶	The measurements focused on the following network parameters: (i) Drop Call Ratio (DCR) (ii) Call Setup Success Ratio (CSSR) (iii) Call Setup time (CST)
Log files	The log files for each test case were stored in different locations with different names. The log files were recorded per network operator. Nemo Analyzer was used to analyse the log files.
Mobile terminal used	The test calls were terminated on each operator's test platform or IVR system.
Network tested	Cell C, MTN, Vodacom and Telkom.
SIM cards	Test SIM cards provided by each operator were used during the drive test.
Vehicle used	A Ford Everest equipped with drive-test equipment was used. All the road traffic rules were observed during the drive test. The speed was maintained to an average of 60km/h in town and built-up areas and an average of 100km/h on highways.

2.4 Statistical significance

The purpose of statistical analysis is to present the statistical accuracy of reported KPIs. This means that one can be "relatively sure" that the results represent the reality (true population mean) and that they did not occur by chance. Statistical theory provides tools to assess the statistical significance of measurement observations with a given sample count and standard deviation. The 95% confidence level was used in calculating the statistical accuracy of the results.

⁶ End User and Subscriber Service Charter Regulations of 2016

2.5 Measurement parameters and targets

2.5.1 Targets

According to the End User and Subscriber Service Charter Regulations of 2016, the following targets have been set as the measurement parameters for the following services:

1. Call Setup Success Ratio – Average Call Setup Success Ratio must be greater than 98%;
2. Call Setup Time – Average Call Setup Time must take less than 20 seconds;
3. Drop Call Ratio – Average Drop Call Ratio must be less than 3%.⁷

2.5.1.1 Call Setup Success Ratio [%]

The Call Setup Success Ratio (CSSR) is the percentage of calls that are successfully set up as a percentage of the total call attempts.

The formula to calculate CSSR is shown below:

$$\text{CSSR} = Y/X * 100$$

Where, Y represents the calls that are call established successfully and X is the total number of call attempts.

2.5.1.2 Drop Call Ratio [%]

Drop Call Ratio (DCR) is the proportion of incoming and outgoing calls, which, once correctly established and therefore having been assigned a traffic channel, are dropped or interrupted prior to the deliberate completion by the user.

The formula to calculate DCR is shown below:

$$\text{DCR} = D/S * 100$$

Where, D represents number of dropped calls and S is the number of successful calls established

⁷ https://www.icasa.org.za/uploads/files/39898_1-4_Icasa.pdf

2.5.1.3 Call Setup Time [s]

Call Setup Time refers to the time interval from the moment a user initiates a network connection request until a complete message indicating call disposition is received by the calling terminal. It is measured from the time a user presses the dial button until the user gets connected to the dialed party.

3 RESULTS AND ANALYSIS

This section provides a summary of the mobile operators' performance results based on the drive test route in the following test areas: Pretoria West, Pretoria North, Bronkhorstspuit, Boksburg and Evaton.

3.1 Accessibility and Retainability Measurements

Table 3: Summary of Results

Route Name	Operator	CSSR (%)	DCR (%)	Call Setup Time [s]
Pretoria West	Cell C	99.83%	1.24%	6.39
	MTN-SA	100.00%	0.00%	3.16
	Telkom	99.13%	1.67%	4.98
	VodaCom-SA	99.83%	1.22%	3.45
Pretoria North	Cell C	99.02%	0.00%	6.55
	MTN-SA	100.00%	0.00%	4.33
	Telkom	98.14%	1.48%	5.08
	VodaCom-SA	99.84%	0.86%	3.74
Bronkhorstspuit	Cell C	99.53%	2.60%	6.38
	MTN-SA	99.85%	1.11%	3.26
	Telkom	94.54%	6.05%	5.58
	VodaCom-SA	99.21%	6.11%	4.05
Boksburg	Cell C	99.73%	0.63%	6.45
	MTN-SA	99.87%	0.63%	3.26
	Telkom	99.87%	0.64%	5.12
	VodaCom-SA	99.22%	1.99%	3.66
Evaton	Cell C	99.56%	0.00%	6.71
	MTN-SA	100.00%	0.39%	3.83
	Telkom	95.81%	2.38%	5.91
	VodaCom-SA	99.71%	1.57%	3.72
Overall results for the above 5 areas	Cell C	99.54%	0.91%	6.50
	MTN-SA	99.94%	0.45%	3.31
	Telkom	97.61%	2.34%	5.33
	VodaCom-SA	99.55%	2.39%	3.73

Table 3 shows voice call measurement results in each route and as an overall for all areas for all the operators. Detailed results are presented in Appendix A.

3.1.1 Call Setup Success Ratio (CSSR)

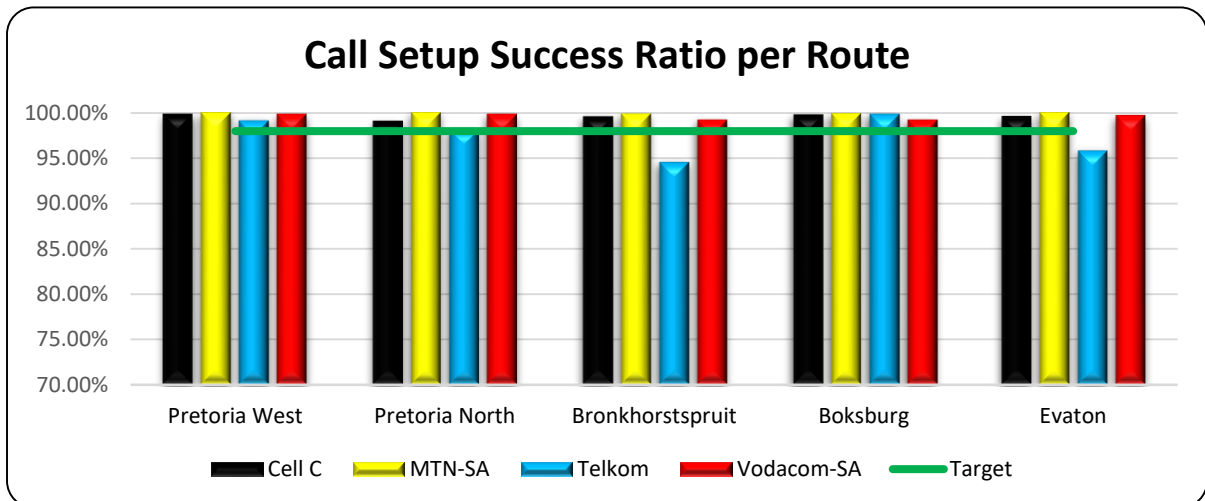


Figure 2: Call Setup Success Ratio (CSSR) per Route

Figure 2 shows that Cell C, MTN and Vodacom met the 98% CSSR target in all tested areas; Pretoria West, Pretoria North, Bronkhorstspuit, Boksburg and Evaton. All the operators met the 98% CSSR target in Pretoria West, Pretoria North and Boksburg. Telkom failed to meet the CSSR target in Bronkhorstspuit and Evaton routes.

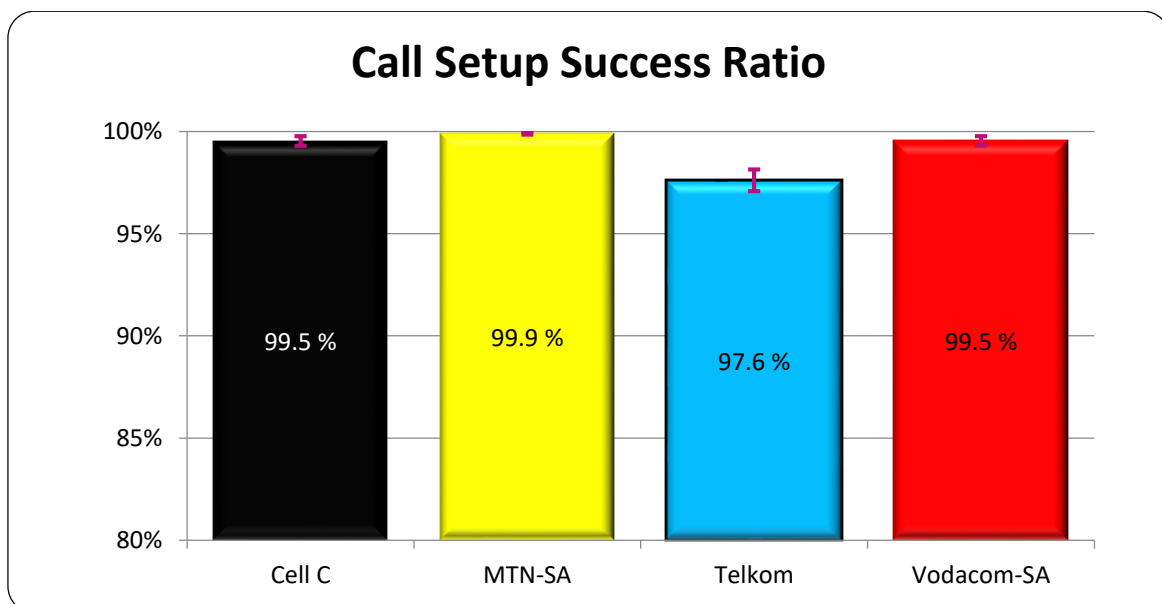


Figure 3: Overall Call Setup Success Ratio with Statistical Significance

Figure 3 shows that MTN’s overall CSSR is the highest, followed by Cell C and Vodacom which are on par and Telkom is the lowest. Cell C, MTN and Vodacom met the overall target of 98%.

3.1.2 Drop Call Ratio (DCR)

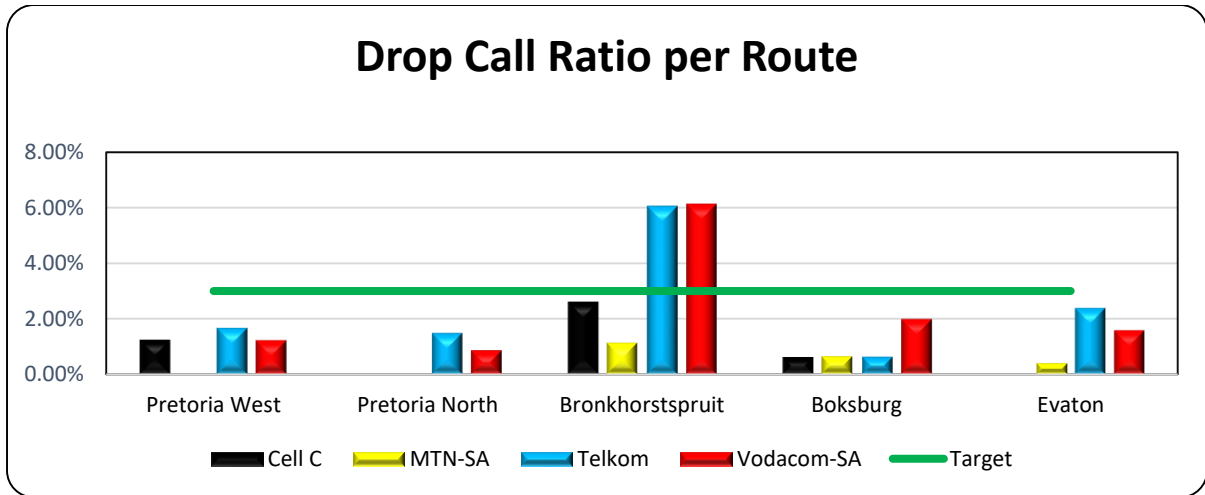


Figure 4: Drop Call Ratio (DCR) per Route

Figure 4 shows that MTN and Cell C met the 3% DCR target in all tested areas. Telkom and Vodacom met the DCR target in Pretoria West, Pretoria North, Boksburg and Evaton but failed to meet the target in Bronkhorstspuit.

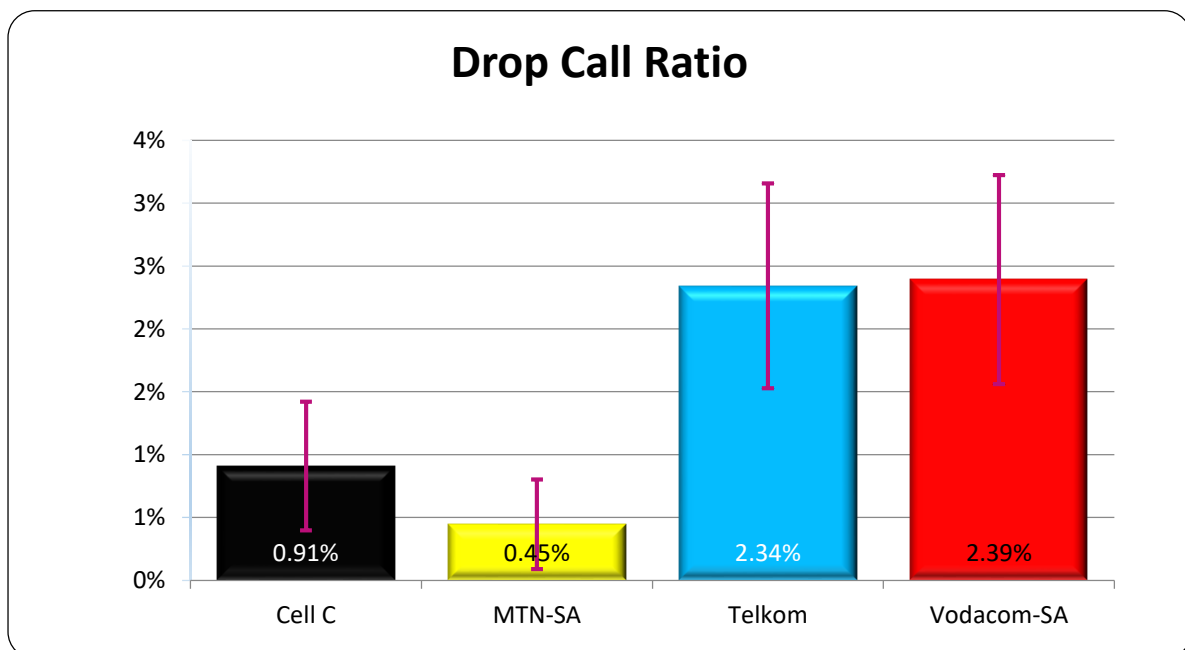


Figure 5: Total Drop Call Ratio with Statistical Significance

Figure 5 shows that MTN’s overall DCR is the lowest followed by Cell C, Telkom and Vodacom in an ascending order respectively. All operators met the 3% DCR target. There is a no statistically significant difference recorded between MTN and Cell C, and between Telkom and Vodacom.

3.1.3 Call Setup Time (CST)

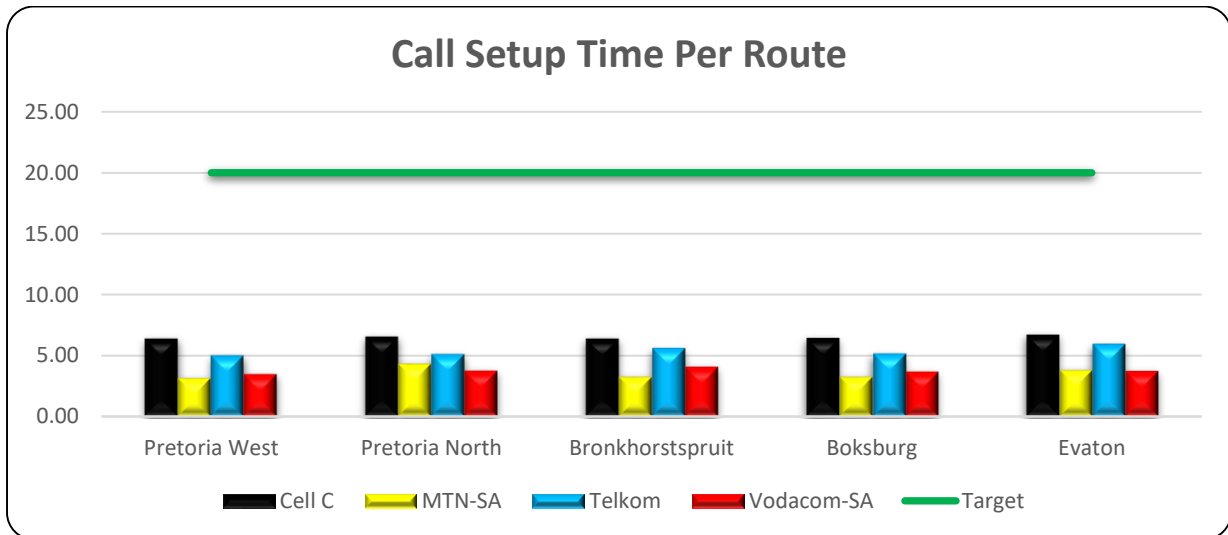


Figure 6: Call Setup Time [s] per area

Figure 6 shows that all operators met the call setup time of 20 seconds target in all tested areas.

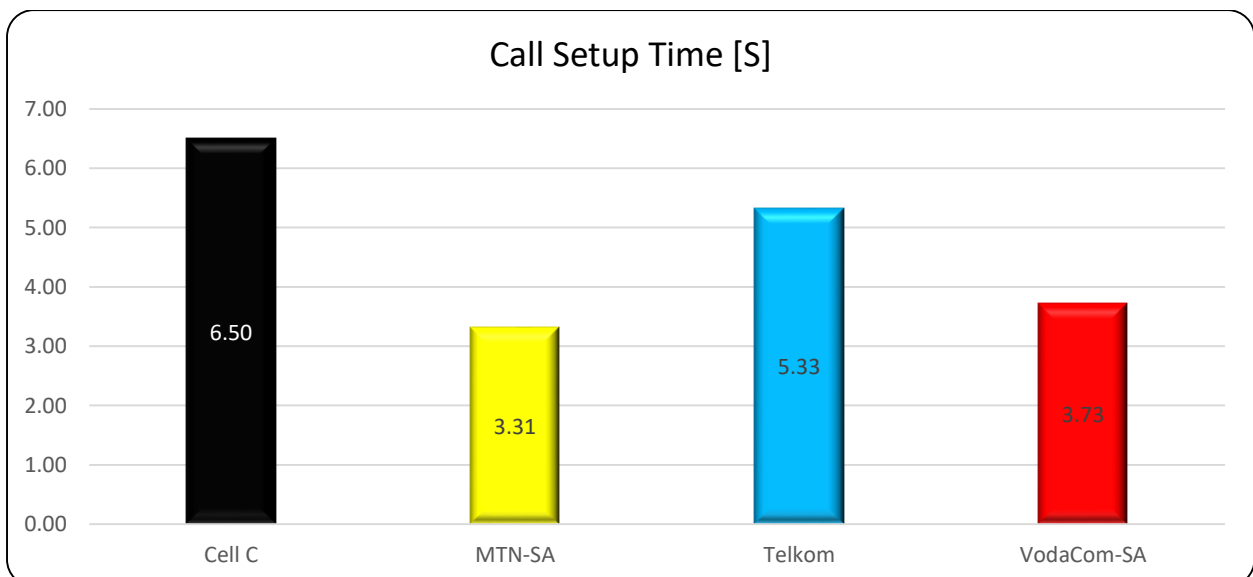


Figure 7: Call Setup Time [s] overall results

Figure 7 shows that the overall results for Call Setup Time. MTN has the lowest overall Call Setup Time, followed by Vodacom, Telkom and Cell C in ascending order.

3.2 Analysis of the serving technology

The serving technology distribution were based on the devices used and the network parameter configuration which varies with the mobile operators. The percentage distribution represents the fraction sampling points, out of the total of sampling points for all results, where the system was on a radio access technology. Figure 8 below shows the statistical distribution of the serving technology during the drive test. All operators serving technology distribution was mainly on LTE.

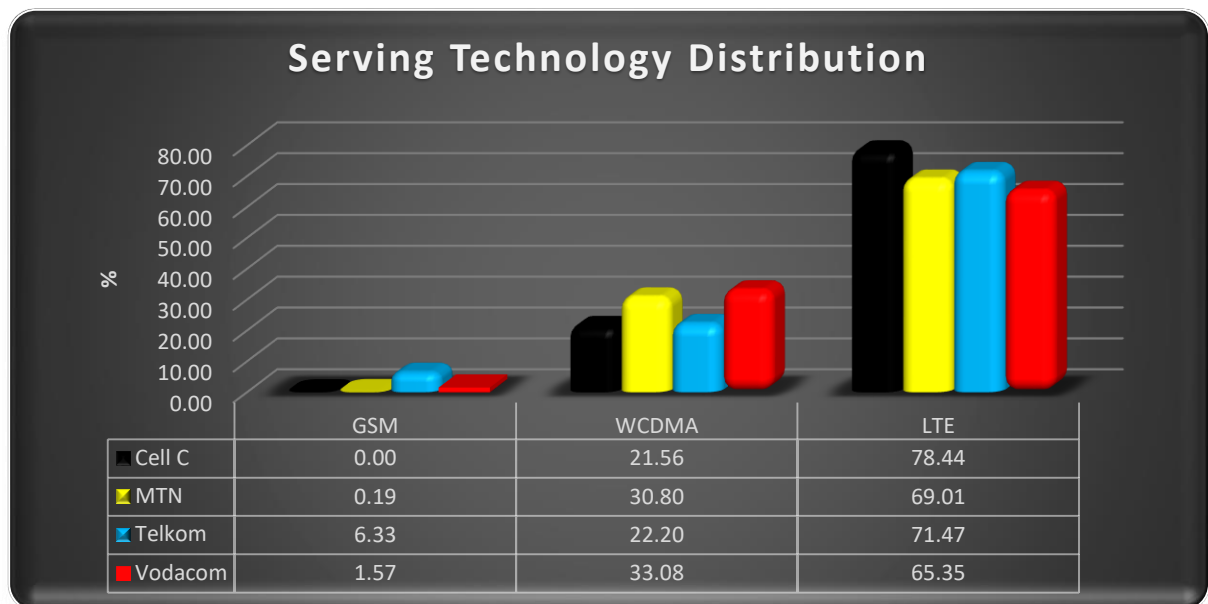


Figure 8: Technology Distribution

The maps in Appendix B show the geographic areas where the radio access technology was selected by the mobile device.

4 CONCLUSION

This section provides the summary and key findings of all measurements. The obtained results illustrate a snapshot of the mobile network performance and customer experience within the measured time and location context.

The results indicate that the end users' Quality of Service and operators' network performance varies significantly on per location basis.

The areas selected were not exclusively monitored in the previous monitoring exercises.

After benchmarking the operators, the results show that in terms of overall Call Setup Success Ratio; MTN, Cell C and Vodacom are the only operators that met the target of 98%, thus meeting the Accessibility target. In terms of overall Drop Call Ratio, all four mobile operators met the DCR target of less than 3% thus meeting the Retainability target. In terms of overall Call Setup Time all four mobile operators met the target.

Twenty-four other areas within the Province were measured in the previous financial years, however, none of these areas were included in this current measurement. There is consistent good performance in the Province, especially in areas within City of Tshwane. The good performance could be attributed due to the following factors:

- High investment in infrastructure, and
- New roaming arrangements between operators.

5 APPENDICES

5.1 Appendix A: Drive Test Results KPI's

Table 4: Drop Call Ratio (DCR) per Route

Route Name	Operator	Phase 1			Phase 2			Total		
		Call Established	Call Dropped	DCR (%)	Call Established	Call Dropped	DCR (%)	Call Established	Call Dropped	DCR (%)
Pretoria West	Cell C	113	1	0.88%	128	2	1.56%	241	3	1.24%
	MTN-SA	114	0	0.00%	130	0	0.00%	244	0	0.00%
	Telkom	111	2	1.80%	128	2	1.56%	239	4	1.67%
	VodaCom-SA	115	3	2.61%	130	0	0.00%	245	3	1.22%
Pretoria North	Cell C	129	0	0.00%	121	0	0.00%	250	0	0.00%
	MTN-SA	131	0	0.00%	130	0	0.00%	261	0	0.00%
	Telkom	132	0	0.00%	138	4	2.90%	270	4	1.48%
	VodaCom-SA	103	1	0.97%	130	1	0.77%	233	2	0.86%
Bronkhorstspruit	Cell C	134	4	2.99%	135	3	2.22%	269	7	2.60%
	MTN-SA	136	3	2.21%	134	0	0.00%	270	3	1.11%
	Telkom	122	3	2.46%	126	12	9.52%	248	15	6.05%
	VodaCom-SA	134	4	2.99%	128	12	9.38%	262	16	6.11%
Boksburg	Cell C	135	1	0.74%	184	1	0.54%	319	2	0.63%
	MTN-SA	139	0	0.00%	177	2	1.13%	316	2	0.63%
	Telkom	139	1	0.72%	175	1	0.57%	314	2	0.64%
	VodaCom-SA	134	1	0.75%	168	5	2.98%	302	6	1.99%
Evaton	Cell C	121	0	0.00%	121	0	0.00%	242	0	0.00%
	MTN-SA	130	1	0.77%	126	0	0.00%	256	1	0.39%
	Telkom	122	1	0.82%	130	5	3.85%	252	6	2.38%
	VodaCom-SA	130	2	1.54%	124	2	1.61%	254	4	1.57%
Total Provincial Samples	Cell C							1321	12	0.91%
	MTN-SA							1347	6	0.45%
	Telkom							1323	31	2.34%
	VodaCom-SA							1296	31	2.39%

Table 5: Call Setup Success Ratio (CSSR) per Route

Route Name	Operator	PHASE 1					PHASE 2					TOTAL				
		Call Attempt	Call Setup	Call Attempt Failure	CSSR (%)	Call Setup Time	Call Attempt	Call Setup	Call Attempt Failure	CSSR (%)	Call Setup Time	Call Attempt	Call Setup	Call Attempt Failure	CSSR (%)	Average Call Setup Time [s]
Pretoria West	Cell C	268	267	1	99.63%	6.32	304	304	0	100.00%	6.46	572	571	1	99.83%	6.39
	MTN-SA	276	276	0	100.00%	3.20	317	317	0	100.00%	3.12	593	593	0	100.00%	3.16
	Telkom	267	266	1	99.63%	4.85	310	306	4	98.71%	5.10	577	572	5	99.13%	4.98
	VodaCom-SA	279	278	1	99.64%	3.55	315	315	0	100.00%	3.35	594	593	1	99.83%	3.45
Pretoria North	Cell C	310	308	2	99.35%	6.52	305	301	4	98.69%	6.58	615	609	6	99.02%	6.55
	MTN-SA	324	324	0	100.00%	5.55	317	317	0	100.00%	3.10	641	641	0	100.00%	4.33
	Telkom	317	315	2	99.37%	4.59	327	317	10	96.94%	5.56	644	632	12	98.14%	5.08
	VodaCom-SA	323	322	1	99.69%	3.71	310	310	0	100.00%	3.77	633	632	1	99.84%	3.74
Bronkhorstspuit	Cell C	315	314	1	99.68%	6.33	317	315	2	99.37%	6.42	632	629	3	99.53%	6.38
	MTN-SA	329	329	0	100.00%	3.23	327	326	1	99.69%	3.28	656	655	1	99.85%	3.26
	Telkom	278	251	27	90.29%	5.13	308	303	5	98.38%	6.03	586	554	32	94.54%	5.58
	VodaCom-SA	324	323	1	99.69%	3.95	310	306	4	98.71%	4.15	634	629	5	99.21%	4.05
Boksburg	Cell C	327	326	1	99.69%	6.45	416	415	1	99.76%	6.44	743	741	2	99.73%	6.45
	MTN-SA	337	337	0	100.00%	3.26	431	430	1	99.77%	3.26	768	767	1	99.87%	3.26
	Telkom	334	333	1	99.70%	5.04	418	418	0	100.00%	5.20	752	751	1	99.87%	5.12
	VodaCom-SA	342	341	1	99.71%	3.48	423	418	5	98.82%	3.84	765	759	6	99.22%	3.66
Evaton	Cell C	305	304	1	99.67%	6.75	371	369	2	99.46%	6.66	676	673	3	99.56%	6.71
	MTN-SA	312	312	0	100.00%	3.82	300	300	0	100.00%	3.83	612	612	0	100.00%	3.83
	Telkom	312	289	23	92.63%	5.65	308	305	3	99.03%	6.16	620	594	26	95.81%	5.91
	VodaCom-SA	316	315	1	99.68%	3.41	378	377	1	99.74%	4.02	694	692	2	99.71%	3.72
Overall results for the above 5 areas	Cell C											3238	3223	15	99.54%	6.50
	MTN-SA											3270	3268	2	99.94%	3.31
	Telkom											3179	3103	76	97.61%	5.33
	VodaCom-SA											3320	3305	15	99.55%	3.73

5.2 Appendix B: Coverage Maps

Serving Technology Details

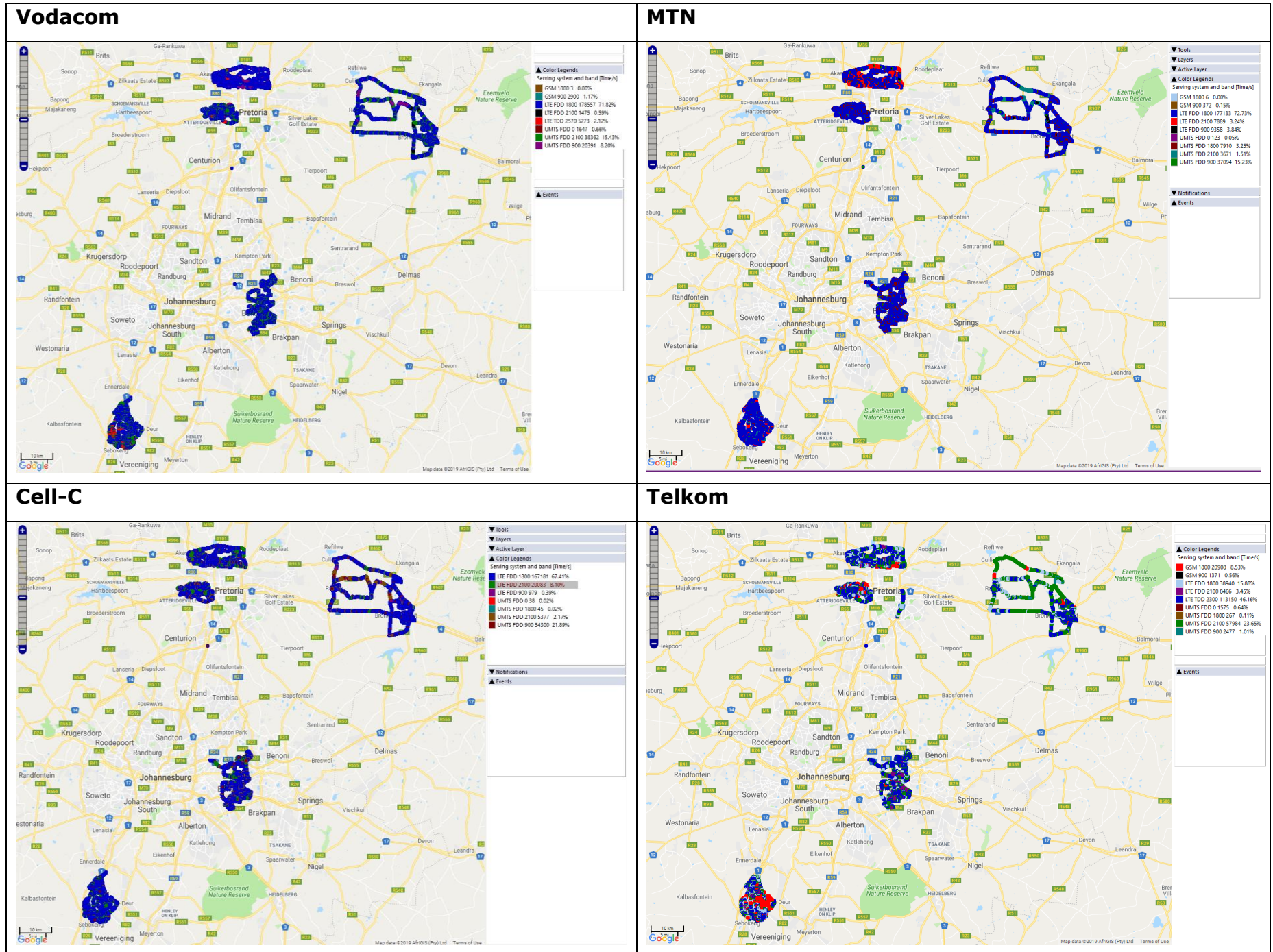


Figure 7: Gauteng Province Serving Technology Plot

5.3 Appendix C: Mobile operators' feedback on the report

The detailed report was shared with the affected mobile operators in order for them to share their plans and remedial action to address issue of poor performance. The improvement plans and remedial actions are provided below.

5.3.1 Vodacom

Vodacom provided feedback and network improvement plans that are in place for the areas that were identified to be negatively affecting customer experience by the Authority's QoS monitoring and shared the following remedial actions:

- Bronkhorstspruit route – The drop calls in the area were caused by congestion in transmission which was as the results of capacity upgrades that were done on the access network. These capacity upgrades added strain on the transmission network which resulted in poor performance. The microwave capacity (transmission network) was increased on 14 June 2019 and has since reduced failures.
- Boksburg and Sunward Park areas route – On the 6th of June 2019, the area had few sites that were out of service due to Dark Fibre Africa (DFA) fibre cut. One of the sites covering the area was also down due to power. Two (2) new sites are planned to be built in the poor performing areas by March 2020.
- Evaton route – RF optimisation and capacity improvement to improve poor performance areas will be completed by 30 September 2019.
- Pretoria West route - Plans to build a new site in the area to resolve coverage issues.

Vodacom provided the above remedies to improve service in all areas irrespective of meeting all the targets.

5.3.2 MTN

MTN promised to remain committed to continuously improve the service across their network irrespective of the good performance demonstrated by the Authority's report.

5.3.3 Cell C

In order to provide Cell C subscriber with good quality of service, Cell C constantly engage with roaming partners to improve network coverage in affected areas.

Cell C's plans and remedies to improve the low performance areas include the following:

- Pretoria North – Network optimisation underway.
- Bronkhorstspuit route – Stability of Eskom and increased vandalism to be addressed.
- Boksburg route – Cell C is experiencing external interference and plans to formally lodge a complaint with the Authority.
- Evaton route – A service site experienced issued while the Authority was conducting measurements, the issue has since been resolved. Transmission is also required.

5.3.4 Telkom

Telkom gave the following response to the Authority's draft report:

Telkom has a new roaming agreement that went live nationally on 1 July 2019, the agreement will have a positive effect on Telkom's network coverage. This agreement includes 4G/LTE roaming and seamless call handover between network and will also significantly improve Telkom's overall network voice and data quality, especially in areas where it has limited or no network coverage.

Telkom plans to further shut-down its GSM network. This is expected to improve our customer experience as all the GSM traffic will be carried through our roaming partner.

- Bronkhorstspuit route – a total of 11 sites planned are in the built and survey phase.
- Evaton route – a total of 12 sites planned are in the build and survey phase.